



Journal of International Business, Innovation and Strategic Management

2021: 5 (2) : 1 - 17

ISSN: 2617-1805

SOCIO-ECONOMIC CONTRIBUTION OF *PROSOPIS JULIFLORA* ON THE LIVELIHOODS OF LOCAL COMMUNITIES IN GARISSA COUNTY, KENYA

***Elyas Hassan Mohamed & ¹Dr. Patrick Mbataru**

* Masters Student, Department of Public Policy and Administration, Kenyatta University, Kenya

¹ Lecturer, Department of Public Policy and Administration, Kenyatta University, Kenya

***Corresponding Author Email: elyas.hassan@gmail.com**

To Cite this Article:

Mohamed, E.H. & Mbataru, P. (2021). Socio-Economic Contribution of *Prosopis Juliflora* on the Livelihoods of Local Communities in Garissa County, Kenya. *Journal of International Business, Innovation and Strategic Management*, 5 (2), 1-17

ABSTRACT

By policy, introduction of *Prosopis Juliflora* (*Mathenge*) was supported by its resilience, notably with standing harsh climatic conditions, a fast rate of growth as well as diversified benefits ranging from animal to human food such as honey and medicines. *Prosopis Juliflora* has spread over a large area in the arid and semi-arid regions in Kenya. There is no conclusive empirical evidence on the socio-economic impact of *Prosopis Juliflora* on the livelihoods of the communities in which it has grown in. Given the debate over the plant in Kenya, whether to uproot or maintain the plant, this study is timely in establishing its socio-economic benefits with an aim of providing policy recommendations based on the experience of the affected people. Besides, there lacks of satisfactory empirical focus on the study with the previous studies indicating research gaps. The study was anchored on the Sustainable Livelihood Framework, Capacities and Vulnerabilities Analysis (CVA) Framework and Institutional theory. The current study sought to examine the socio-economic contribution of *Prosopis Juliflora* to the livelihood of local communities in areas which are invaded by the plant, in this study, Garissa County, Kenya.



Specifically, the study established the contribution of *prosopis Juliflora* on improving livestock production, households diversification of income and households ownership and access to productive assets in Garissa County, Kenya and its link to livelihood. A descriptive research design was adopted with the study targeted Local Administrative Officers of the wards in Fafi Sub-County, the 7 sub counties and 23,671 households of Fafi Sub County in Garissa County, Kenya. The study targeted the heads of households. The sample size was 384 households randomly sampled from the area of study. The study results revealed that all the *prosopis juliflora* dimensions of contribution had a positive and significant relationship with livelihood of local communities in Garissa County, Kenya. However, the magnitude of the contribution was different for the specific *prosopis juliflora* dimensions. The *prosopis juliflora* households' diversification and finally the ownership and access to productive assets on the livelihood of local communities in Garissa County, Kenya. Consequently, this study provides national and county governments with insights of how to improve livelihood of local communities through *prosopis juliflora*. The study recommended that national and county governments should adopt a policy of enhancing *prosopis juliflora* positive contribution to go a long way for improvement of livelihood of local communities in Garissa County and other arid and semi-arid areas in Kenya.

Key Words : *Improving Livestock Production , Income Diversification, Ownership and Access to productive assets, Livelihood, Kenya*

BACKGROUND OF THE STUDY

Prosopis juliflora (*P. juliflora*) is an evergreen tree native to Central America, the Caribbean, and South America. It was introduced to tropical regions of the world in the early 1970s and late 1980s in response to a global concern about desertification, fuel wood shortages, and mitigating the effects of desertification in these areas (Mwangi & Swallow, 2008). *Prosopis juliflora* plant is found in most drylands areas which makes up to 80 percent of the Kenyan land. *Prosopis juliflora* as other invasive species known are usually introduced accidentally or intentionally in a given region or area before they begin having negative effects on the environment. The invasive species normally affect the socio-economic activities of the residents in the areas in which they invade (De Brito, Ferrari & Giordani, 2017). The *P. juliflora* is innate to Latin America, although the exact period of introduction remains unknown. However, due to its prolific nature and alleged poisonous sap, its introduction has faced criticism from stakeholders. It is reported to have been introduced in Kenya as an alternative animal fodder in the 30s as well as high worth cash crop (Mwangi & Swallow, 2008). When drought affected most parts of the country in the 1970s, there was intense planting of the plant as a mitigation against drought and deforestation. The first planting can be traced down to the Kenyan coast and the Menengai area in Nakuru County, Kenya (Choge *et al*, 2007).

The other reasons for mass introduction of the plant in Kenya was to aide in afforestation, reduce desertification and take care of the shortages in fuel which was prevalent in the 1970s and 80s. The main reason for this option was based on the ability of *prosopis juliflora* to survive the harsh climatic conditions and thrive in drylands. However, with time, *P. juliflora* developed into an impermeable grove which can attack the rangelands and cause damage to crop farming lands (Girma, Urge, & Animut, 2011). As a result, this plant is regarded as one of the top 100 least wanted plants (Mwangi & Swallow, 2005). In China, *Prosopis juliflora* has been used to restore the degraded and marginal lands to regain the lost ecosystems and biodiversity systems. However, during the last few decades, the invasive tree has become a challenge since it has led to loss of native species, loss of biodiversity and land degradation in the areas it has invaded (Sato, 2013).



In India, the intention of introducing the plant was to control the degradation of land and improve biodiversity especially the marginalized lands. However, *Prosopis juliflora* has become a noxious weed which negatively affect environment affecting the economy of the landowners and farmers (Bandara, Ranasinghe & Vlosky, 2020). Pods from the species are harvested in South Africa to make organic remedies ('manna') that are supposed to help humans regulate their blood sugar levels thus it is economically beneficial in South Africa (Wise et al. 2012). Similarly, products from the plant have long been used as a primary or secondary source of income in Malawi (Chikuniet al. 2004). On the contrary, *Prosopis juliflora* has harmed native species in Ethiopia and it is predicted that this invasive tree will have major effects for the region's long-term sustainability unless it is confined and its density controlled (Ilukor et al., 2016). Correspondingly, its entrance into Sudan has resulted in a number of environmental issues (Badri et al., 2017).

In Kenya, by policy, introduction of *Prosopis juliflora* is (*Mathenge*) was supported by its resilience, notably withstanding harsh climatic conditions, a fast rate of growth as well as diversified benefits ranging from animal to human food such as honey and medicines (Haji, Schaffner, Legesse & Dadie, 2018) and to help the people overcome charcoal and grazing problems. Yet, on its introduction, the *Prosopis juliflora* is reported to have negative effects, ranging from invading the lands and affecting crops, livestock and humans (Maundu et al. 2009). Some of the negative impacts include invasion of grazing land, blocking of roads, irrigation canals and water points. In addition, the plant has tended to reduce farmland. The pods are said to be poisonous and this has led to death of animals which consume its indigestible pods. Since the pods are high in sugar, there have been plausible cases of tooth decay in animals (Zeilaet al. 2009). This have triggered policy debates regarding its management against its weighted socio-economic contributions. Often, interventions to stabilize the ecology have undisputed consequences. However, this does not preclude the socio—economic benefits of such interventions.

STATEMENT OF THE PROBLEM

The question of whether *Prosopis* should be maintained or uprooted in areas where it is overriding lingers (Kumar, Selvakumar & Sreeja, 2015). Currently, conservationists, researchers and development workers hold divided reasoning on the species. There is no conclusive empirical evidence on the socio-economic impact of *prosopis* on the livelihoods of the communities in which it has grown in. Even existing empirical studies have diversified results on the subject. In as much as some scholars such as Sirmah, Muisu, Mburu, Dumarçay & Gérardin (2008) and Admasu (2008) argue that the plant positively impacts on socio-economic households of the community.

However, Maundu, et al. (2009), Haregeweyn, Tsunekawa, Tsubo, Meshesha and Melkie (2013), Andersson (2005) and Ayanuet al (2015) believe that the plant has more demerits than advantages. Given the debate over the plant in Kenya, whether to uproot or maintain the plant, this study is timely in establishing its socio-economic benefits with an aim of providing policy recommendations based on the experience of the affected people. Besides, there lacks of satisfactory empirical focus on the study with the previous studies indicating research gaps. Maundu et al. (2009) looked at the impact of *Prosopis juliflora* on Kenya's semi-arid and arid ecosystems, Anderson (2005) investigated the of the species through GPS and did not establish its impact on livelihood while Oduor and Githiomi (2013) was more keen on the fuel-wood energy properties of both *Prosopis juliflora* and *Prosopis pallida* and not its impact on livelihood. These studies present a conceptual research gaps which motivates this study to focus on the socio-economic role of *prosopis juliflora* to the livelihood of resident communities in Garissa County, Kenya.



OBJECTIVES OF THE STUDY

- i. To establish the contribution of *prosopis Juliflora* on improving livestock production in Garissa County, Kenya
- ii. To assess the contribution of *prosopis juliflora* on the households diversification of income in Garissa County, Kenya
- iii. To examine the contribution of *prosopis juliflora* on the households ownership and access to productive assets in Garissa County, Kenya

THEORETICAL FRAMEWORK

The study was grounded on the Sustainable Livelihood Framework, as well as Institutional Theory. The Sustainable Livelihood Framework (SLF) was developed by the Department for International Development (DFID) (1999). People have objectives (life outcomes) that they desire to achieve in their lives, according to this theory. They pursue them through specific activities (livelihood strategies) and the use of certain resources (livelihood assets) that they have access to. Structures and procedures, on the other hand, act as intermediaries, determining access, conditions of trade, and returns. The interaction between these activities occurs in a more sensitive external environment. In this study, the SLF is predominantly pertinent to comprehend and mitigate the vulnerability of the people of in Garissa County, Kenya to the invasion of *P. juliflora*. The theory highlights the various livelihoods dependent on the environment and how it can be affected by natural invasions and how the community can come up with strategies to lessen it and survive (Ekins, Simon, Deutsch, Folke & De Groot, 2003).

Institutional Theory proposed by Powell and DiMaggio (1991) validates the mechanisms for understanding natural resource governance. The theory defines institutions in form of rules, formal structures, norms and regulations to govern actions in the society. According to the theory, a set of 'rules in use' can be used to encourage good deeds through rewards and discourage certain activities through penalties and punishment. In application to this study, the theory is used to explain some of the governance and policy issues regarding management of natural resources such as the *prosopis juliflora* to realise maximum economic benefits. The theory argues that compliance to a set of rules that aim to govern management of resources for instance, can be enhanced through provision of either payoffs or penalties. In so doing, a higher compliance rate can be witnessed and thus ensuring proper management of resources. By setting regulations and policies that discourage use of products from the plant, such as charcoal, the government policy aims to ensure sustainable exploitation of the plant to realize more sustainable economic benefits. The theory is hence suitable in this study.

EMPIRICAL LITERATURE REVIEW

Koech (2020) determined if *Prosopis* seed pods might be used in a normal dryland cattle system in Kenya and indicated that supplementing the goats with *Prosopis* seed pods, the most cost-effective option, is lucrative. Mahgoub et al. (2004) found that animals were in great condition throughout the *Prosopis* supplementation phase. They discovered that feeding *Prosopis* pods to Omani sheep had no negative impact on their health, despite the fact that it contained *Prosopis* pods, which have been linked to health issues in goats in previous studies. Scholar and Syomiti (2015) sought to establish how *Prosopis juliflora* can be economically rewarding to pastoral communities in Kenya's rangelands and indicated that harvesting, processing, value addition and marketing of *prosopis* products as animal feed is a viable option to exploit this noxious weed.



Mutavi's (2020) research focused on the impact of *Prosopis juliflora* pod and leaf meal on the physical qualities of goat teeth and bones in Kitui County, Kenya and established that the species was a major threat to pastureland cattle productivity and that other options, such as biofuel production, should be explored. Mohammed (2012) investigated the household's perceptions of *Prosopis juliflora* and their effects on pastoral livelihood diversification techniques in Ethiopia's Afar regional state's Gewane area. According to the findings, there was a significant positive relationship between household perceptions of the species and their livelihood diversification plan, as well as crop and livestock production complementarities.

The economic effect and community management of the *Prosopis juliflora* invasion in Sweimeh Village, Jordan, were investigated by Al-Assaf, Tadros, and Othman (2020). It was established that *P. Juliflora* played a dual role in household livelihoods, according to the findings: it was commonly utilized for firewood, fodder, and charcoal, all of which gave benefits. At the same time, by intruding on agricultural land and harming people and animals, the invasion diminished household welfare. Masakha and Wegulo (2015) looked at the *Prosopis juliflora* Invasion in Kenya and revealed that in Baringo County, the plant is used by the locals for charcoal production, sale posts, poles, and pods in order to improve their livelihoods, according to the research. On the other hand, a study by Datona (2014) in the horn of Africa gave a contrary observation that despite its importance, the plant negatively affects the inhabitants whose farms it has invaded. It deteriorates pasture land and thus affects the grazing lands. Thus, the economic benefits from livestock are severely affected.



CONCEPTUAL FRAMEWORK

Independent Variable

(Socio-Economic Contributions)

Dependent Variable

(Livelihood of Local Communities)

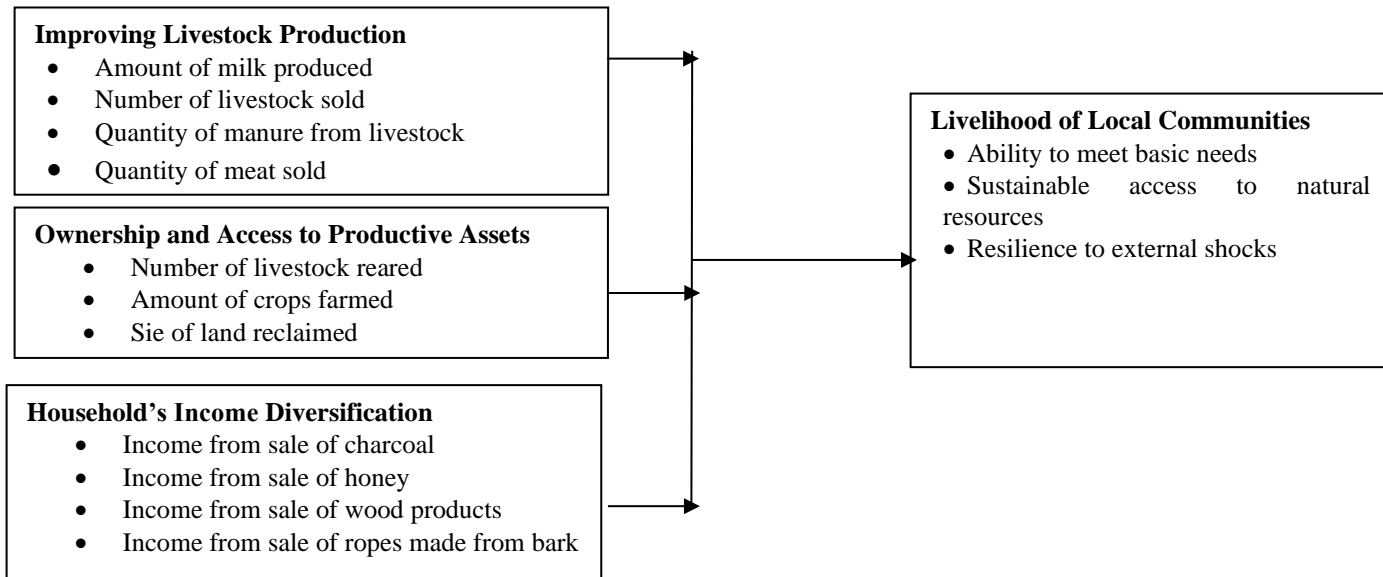


Figure 1 Conceptual Framework

RESEARCH METHODOLOGY

The study's research design was descriptive research design, which allowed for the collection of both qualitative and quantitative data. The focus area was Fafi Sub county of Garissa County, Kenya. The main land use in the area is livestock production, in conjunction with subsistence farming around homestead and irrigated agriculture. The land ownership practice is communal tenure ship. This area was considered suitable for the study since it is the most covered by the species of *Prosopis* compared to other Sub Counties in Garissa. As a result, its impact on the environment and livelihood can well be explained by the households of the area who largely depend on livestock production, combined with subsistence farming around homestead and irrigated agriculture.

The study targeted 13 Local Administrative Officers of the 13 wards in Fafi Sub County, 7 Sub County Environmental Officers of the 7 counties, 7 Sub County Agricultural Officers of the 7 sub counties and 23,671 households of Fafi Sub County in Garissa County, Kenya. The local administrative officers, county environmental officers and county agricultural officers participated in an interview while the household's heads participated in responding to the questionnaire. Table 1 indicates the target population.



Table 1 Study Population

Category	Population
Local Administrative Officers of Fafi Sub county (13 Wards)	13
County Environmental Officers	7
County Agricultural Officers	7
Households of Fafi Sub County	23,671
Total	23,698

Source: Garissa County Administrative Offices, Kenya National Bureau of Statistics (2019)

A sample size of 384 was determined by Fisher’s (1983) formula which is suitable for a population greater than 10,000. The formula is shown below :

$$n = \frac{Z^2pq}{d^2}$$

In the formula, n = is the sample size when the population is above 10,000 ; P = the fraction of the sample with the traits similar to that of the population ; q = (1-p) is the fraction of the sample with the traits absent from that of the population ; d = error margin ; Z = Z score of a normal distribution. The sample was distributed through stratification then randomly sampled. A mixed method was adopted in this cross examination where the data was collected through questionnaires and interviews. Mixed methods analysis was employed since both qualitative and quantitative data were employed. Thematic / content analysis was used to analyse qualitative data, with main topics from the interview and open-ended questions being categorized into primary themes and then presented as narratives.

The quantitative data was coded, entered into the computer using the Excel program, sorted, cleaned, and analyzed using the SPSS computer program version 22. Frequencies, means, and standard deviations were used to analyse the data. Figures and tables were used to summarize the findings. The objectives were met using more advanced statistical analysis (regression analysis). To determine socio-economic contribution of *Prosopis Juliflora* products to the livelihood of local communities in Garissa County, Kenya, Kenya, the following regression model was adopted:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \varepsilon$$

Where Y = Livelihood of local communities in Garissa County, Kenya ; β_0 = Constant ; X_1 = Improving Livestock Production ; X_2 = Household’ Diversification of Income ; X_3 = Household’s Ownership and Access to Productive Assets ; $\beta_1 - \beta_3$ are Coefficients of the independent variables and ε = Error term



FINDINGS AND DISCUSSIONS

The study interrogated a total of 384 households out of which 277 responded. This resulted in a response rate of 72 percent which is satisfactory.

Contribution of *Prosopis Juliflora* on Improving Livestock Production

The section provided a description of the contribution of the species on livestock production. The results in Table 2 indicated that most households incorporate *P. juliflora* seed in the livestock meals to increase yields and that the use of *P. juliflora* meals have reduced livestock feeds costs. There was also an agreement that nutritional value of *P. juliflora* is high enough to increase livestock yields as well as form a balanced animal feed supplements (Mean > 3.5).

This implies that *P. juliflora* is indeed important in improving livestock production. On whether *P. juliflora* has a fortified anthelmintic to control gastro-intestinal parasites, there was a moderate agreement to indicate that some households were not sure (Mean = 3.35). Overall, there was a strong agreement that the species has played a role of improving the livestock production through its nutritional value.

These findings are consistent with that of the open-ended question which sought to establish other contributions of the species to livestock productions. The respondents agreed that the species is important in providing extra nutrients through its pods and leaves. Others however indicated that its seeds are dangerous and may cause indigestion in the livestock which lowers production. Some of the quoted responses are as shown:

“..... *P. Juliflora* helps my livestock to supplement the feeds because its fodder its very healthy. It helps the livestock to produce more milk.....”

“..... *P. Juliflora* helps to balance the nutrients requirements for the young livestock. The pods are very important for the growth of livestock.....”

“..... despite its benefits, the seeds from the species is dangerous to animals and can kill them. It affects smooth digestion.....”

These findings thus demonstrate that in as much as the species is beneficial, it can also be a curse to the livestock production. Besides its benefits, the seeds are harmful and can lower livestock production since it hampers smooth digestion. In a related interrogation, Kumar, Selvakumar and Sreeja (2015) demonstrated that in India, *Prosopis Juliflora* has had some economic benefits in improving livestock production yields.

Table 2 Contribution of *Prosopis Juliflora* on improving Livestock Production

Statement	Mean	Std
We incorporate <i>P. juliflora</i> seed in the livestock meals to increase yields	4.908	.234
<i>P. juliflora</i> meals have reduced livestock feeds costs	4.543	.276
The nutritional value of <i>P. juliflora</i> is high enough to increase livestock yields	3.998	.908
<i>P. juliflora</i> forms a balanced animal feed supplements	3.734	1.908
<i>P. juliflora</i> has a fortified anthelmintic to control gastro-intestinal parasites	3.354	.998
Average Mean	4.11	



Contribution of *Prosopis Juliflora* on Household’s Income Diversification

The contribution of *Prosopis Juliflora* on household’s income diversification was similarly evaluated as shown in Table 3. The results indicate that indeed *P. juliflora* helps the local community in enhancing their income through the sale of its products such as charcoal, honey and wood products (Mean > 3.50). However, the income generation through the sale of ropes and fodder was to a moderate extent (Mean < 3.50). Nevertheless, there was an overall agreement that *Prosopis Juliflora* has contributed to the household’s income diversification through the sale of its products. This is consistent with Shiferaw et al. (2020) who demonstrated the importance of the species in income diversification activities through the sale of charcoal and fodder.

These findings are consistent with that of the open-ended question which sought to establish other contributions of the species to income diversifications. There was a general consensus that indeed the species has driven alternatives for extra earning up. When there is drought and livestock production and income is low, most of the local households engage in extra activities related to the sale of the products from the species so as to earn more. Apart from the above mentioned, the households also sell fodder and the seeds from the plant to earn more. The income is however not much since the supply of the plant is very high in the region. Masakha and Wegulo (2015) also emphasized the importance of the species in diversification of incomes. Some of the quoted responses are as shown:

- “..... during drought and famine when I can’t earn much from livestock, I sell charcoal and wood products from the plant in the local environment.....”
- “..... I practice mixed farming and the plant has provided a good ground to rear and attract bees. As a result, it supports my income from the sale of honey.....”
- “..... despite its benefits, the seeds from the species is dangerous to animals and can kill them. It affects smooth digestion.....”

Table 3 *Prosopis Juliflora* on Household’s Income Diversification

Statement	Mean	Std
<i>P. juliflora</i> helps the local community to enhance their income through charcoal sales	4.237	.090
<i>P. juliflora</i> helps the local community to enhance their income through honey sales	4.098	.985
<i>P. juliflora</i> helps the local community to enhance their income through sale of wood products	3.987	.008
<i>P. juliflora</i> helps the local community to enhance their income through sales of ropes from its bark	3.387	1.587
<i>P. juliflora</i> helps the local community to enhance their income through fodder sales	3.234	1.616
Average Mean	3.788	



The study further sought to describe the income range from the sale of products related to the species such as honey, wood, charcoal and fodder. The results in Figure 2 indicated that majority of the households, 35 percent obtained less than Kshs. 25,000 monthly from the sale of the products. With the increased supply of the species in the region, it was economically challenging to get more from the sale of its species since majority of the households can have access to it. However, these results are an indication that the households use the species to diversify and complement their incomes.

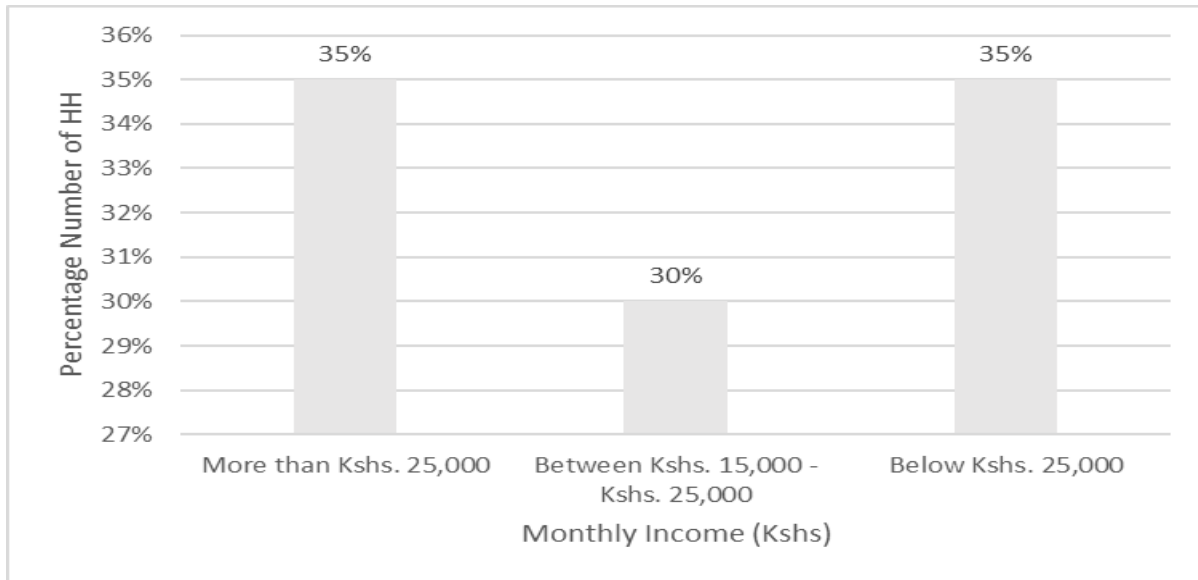


Figure 2 Monthly income from the sale of *P. juliflora* Products.

The study findings are in agreement with the findings conducted in India by Kumar, Selvakumar and Sreeja (2015) on whether *P. Juliflora* was currently a valuable species in the ASAL areas of India. It was demonstrated that even though it has some economic benefits, the species also invades the lands and has negative effects on sea water intrusion.

Contribution of *Prosopis Juliflora* on Household’s Ownership and Access to Productive Assets

The section presented a description of the contribution of *P. Juliflora* on the household’s ownership and access to productive assets. The results in Table 4 indicated an agreement that due to availability of fodder from *P. juliflora* most households have increased the number of livestock reared, due to invasion of *P. juliflora* most households have reduced the size of cultivated farm, the crop harvests have reduced, the capacity to increase the quantity of livestock products such as milk has reduced and the capacity to diversify the types of crops farmed has also reduced (Mean > 3.50).

This generally implies that invasion of the species has had a detrimental impact on the ownership of productive assets such as cultivated land, crop harvests, livestock reared and quality of livestock products.

These findings are consistent with that of the open-ended question which sought to establish other contributions of the species to ownership of productive assets. Most of the households who responded indicated that the species has reduced their quantity of pasture, cultivatable lands and killed some of the livestock through their seeds. Thus, its impact on



productive assets was seen as negative. Some of the quoted responses are as shown:

“..... before its invasion our grazing land was big but now, it has reduced significantly as a result of its invasion.....”

“..... the cultivatable land for crop farming has reduced significantly as a result of the invasion of the species.....”

“..... the quality of the crop harvests has gone down due to diseases from the species.....”

These findings are not new since they complement the results by Maundu et al. (2009) who demonstrated that the species has turned into production of negative effects ranging from invading the lands and affecting crops, livestock and humans.

Table 4 Contribution of *Prosopis Juliflora* on Household’s Ownership and Access to Productive Assets

Statement	Mean	Std
Due to availability of fodder from <i>P. juliflora</i> I have increased the number of livestock reared	4.219	.987
Due to invasion of <i>P. juliflora</i> I have reduced the size of cultivated farm	4.098	.095
Due to invasion of <i>P. juliflora</i> the crop harvests have reduced	3.999	.124
Due to invasion of <i>P. juliflora</i> the capacity to increase the quantity of livestock products such as milk has reduced	3.898	.423
Due to invasion of <i>P. juliflora</i> the capacity to diversify the types of crops farmed has reduced	3.882	.018
Average Mean	4.02	

Livelihood of Local Communities

In this part, there is a description of the livelihood of the communities in Garissa County, Kenya in which the species has invaded. This is presented in Table 5. The results indicated that most of the respondents agreed that their resilience to external shocks, purchasing power and ability to meet basic needs has been improved by *P. juliflora* (Mean > 3.50). However the contribution of the species to improvement of their source of income, social status in the society and ability for sustainable access to natural resources is moderate (Mean < 3.50). Related studies by Oliveira, Costa and Fonseca (2018) (South America) ; . Maundu *et al.* (2009) (Kenya) and Admasu (2008) (Ethiopia) also demonstrated that the HH from the species-invaded regions had a low socio-economic livelihood.



Table 5 Livelihood of Local Communities

Statement	Mean	Std
My ability to meet basic needs has been improved by <i>P. juliflora</i>	3.987	.435
My ability for sustainable access to natural resources <i>P. juliflora</i>	3.456	.432
My resilience to external shocks has been improved by <i>P. juliflora</i>	3.547	.634
My purchasing power has been advanced by <i>P. juliflora</i>	3.765	.126
My source of income has been improved by <i>P. juliflora</i>	3.134	.191
My social status in the society has been improved by <i>P. juliflora</i>	1.897	.162
Average Mean	3.30	

Multiple Regression Analysis

A multiple regression model was used to establish the socio-economic contribution of *prosopis Juliflora* to the livelihoods of local communities in Garissa County, Kenya. The contribution the species to livestock production, households diversification of income and households ownership and access to productive assets was regressed against livelihood. The model summary results are presented in Table 6. It was established that the contribution the species to livestock production, households diversification of income and households ownership and access to productive assets explains up to 62.1% of the variation in livelihood of the local communities. This is a strong reflection considering that majority of the households in the region are livestock keepers and the species provides fodder to the animals in addition to other nutrients.

Table 6 Model Summary

R	R ²	Adjusted R ²	Std. Error of the Estimate
.788	.621	.589	.02131

The model fitness was also tested as shown in Table 7. The regression model linking the contribution of the species to livestock production, households diversification of income and households ownership and access to productive assets to livelihood was established to be a good fit and significant (P-value < 0.05). This implies that the model was significant in prediction through the same population.



Table 7 ANOVA

	Sum of Squares	d.f	Mean Square	F	Sig.
Regression	199.885	3	66.628	149.056	.000
Residual	121.991	273	0.447		
Total	321.876	276			

The model coefficients results (Table 8) were used to indicate the magnitude and significance of the effects. These are the results used to answer the study questions.

Table 8 Coefficient Results

	Unstandardized Coefficients		Standardized Coefficients	t	P-values.
	Beta	Std. Error	B		
(Constant)	5.876	2.098		2.800	.000
Livestock production	0.678	.113	.465	5.987	.000
Household's Income Diversification	0.599	.121	.354	4.899	.000
Ownership and access to productive assets	0.571	.187	.255	3.298	.000

Findings in Table 8 show that the contribution of *Prosopis Juliflora* on improving livestock production had coefficients of the estimate which was significant basing on $\beta_1 = 0.678$ (P-value = 0.000). This implies that there is a significant relationship between the contribution of *Prosopis Juliflora* on improving livestock production and livelihoods of local communities in Garissa County, Kenya. The findings imply that an increase in the contribution of *Prosopis Juliflora* on improving livestock production can significantly improve the livelihood of the local communities. Masakha and Wegulo (2015) demonstrated that the species contributed significantly to the Baringo household's livelihood although it also had a negative effect.

In addition, the findings indicate that the contribution of *Prosopis Juliflora* on household's income diversification had coefficients of the estimate which was significant basing on $\beta_2 = 0.599$ (P-value = 0.000 which is less than $\alpha = 0.05$). This demonstrated that there is a significant relationship between the contribution of *Prosopis Juliflora* on household diversification of income and livelihoods of local communities in Garissa County, Kenya. The findings imply that an increase in the contribution of *Prosopis Juliflora* on improving household's income diversification can significantly improve the livelihood of the local communities. Shitanda *et al.* (2013) similarly indicated that the species has the potential for commercial usage.

Further, the findings indicate that the contribution of *Prosopis Juliflora* to the households ownership and access productive assets had coefficients of the estimate which was significant basing on $\beta_3 = 0.571$ (p-value = 0.000 which is less than $\alpha = 0.05$). This demonstrated that there is a significant relationship between the contribution of *Prosopis*



Juliflora households ownership and access productive assets and livelihoods of local communities in Garissa County, Kenya. The findings imply that an increase in the contribution of *Prosopis Juliflora* to the households ownership and access productive assets can significantly improve the livelihood of the local communities. This findings is consistent with that of Datona (2014) who established that despite its importance, the plant deteriorates pasture land significantly.

CONCLUSIONS

The main purpose of the study was to examine the socio-economic contribution of *P. Juliflora* on the livelihood of local communities in Garissa County, Kenya. The results showed that *prosopis Juliflora* improving livestock production contributed positively and significantly on the livelihood of local communities in Garissa County, Kenya. The *prosopis Juliflora* improving livestock production included controlling desertification, controlling soil erosion, controlling sand dunes, improving fertilizer status, aesthetic beauty, noise pollution, furniture wood and acting as a wind break. In addition, from the study results showed that *prosopis juliflora* on the households diversification contributed positively and significantly on the livelihood of local communities in Garissa County, Kenya. The community management of the *P. Juliflora* included Ingredients for cultural dishes, venue for cultural events and products for cultural ceremonies.

Further, the study established *prosopis juliflora* on the household's ownership and access to productive assets contributed positively and significantly on the livelihood of local communities in Garissa County, Kenya. *Prosopis juliflora* on the household's ownership and access to productive assets included issues in regard to provision of food to the local residents, herbal Medicines and animal feeds. The local community economically benefited from the sale of honey, fuel of products (charcoal), medicines from the plants, fodder from the plants, sale of timber and firewood. The other benefits included he community to meet basic needs, sustainable access to natural resources, resilience to external shocks, and purchasing power of the communities and provided the source of income of the communities.

POLICY IMPLICATIONS

The study found that *prosopis Juliflora* had a significant positive and negative contribution livelihood of the local communities in Garissa County, Kenya. The policy implications will be highly relevant in regard to *prosopis Juliflora* which require to be implemented through multi-dimensional approach (community level of knowledge, community management, institutional arrangements and environmental income) which may render improved livelihood to the local communities rather than a single-dimensional approach in the in the communities. This has important implications for the design policy implementation strategies to policymakers. Moreover, the strength of the contribution of level of knowledge, institutional arrangements, environmental income and community are highly relevant for policymakers in the country in the context of on-going environmental management and institutional reforms. If an environmental and policy making process can render larger positive effects on the livelihood of the local communities, designing adequate policy framework *Prosopis Juliflora* could help significantly in increasing the quality of life of the local communities in terms of ability to meet basic needs, sustainable access to natural resources and resilience to external shocks. The study thus assists policymakers in coming up with *Prosopis Juliflora* policies geared towards improving livelihood of local communities especially in the ASALs in Kenya, based on environmental management dimensions.

CONFLICT OF INTEREST

No potential conflict of interest has been recorded by the authors.



REFERENCES

- Admasu, D., (2008). Invasive plants and Food Security. The case of *Prosopis juliflora* in the Afar region of Ethiopia, 1–13. FARM-Africa, IUCN, Ethiopia.
- Alvarez, M., Heller, G., Malombe, I., Matheka, K. W., Choge, S., & Becker, M. (2019). Classification of *Prosopis juliflora* invasion in the Lake Baringo basin and environmental correlations. *African Journal of Ecology*, 57(3), 296-303.
- Andersson, S. (2005). Spread of the introduced tree species *Prosopis juliflora* (Sw.) DC in the Lake Baringo area, Kenya.
- Badri, A. M., Garbi, M. I., Kabbashi, A. S., Saleh, M. S., Yousof, Y. S., Mohammed, S. F., ... & Magzoub, A. A. (2017). In vitro anti-bacterial activity of *Prosopis juliflora* leaves extract against pathogenic bacteria. *Adv. Med. Plant Res*, 5, 37-40.
- Berhanu, A., & Tesfaye, G. (2006). The *Prosopis* dilemma, impacts on dryland biodiversity and some controlling methods. *Journal of the Drylands* 1 (2): 158–164.
- Blicharska, M., & Mikusiński, G. (2014). Incorporating social and cultural significance of large old trees in conservation policy. *Conservation Biology*, 28(6), 1558-1567.
- Choge, S. K., Pasiecznik, N. M., Harvey, M., Wright, J., Awan, S. Z., & Harris, P. J. C. (2007). *Prosopis* pods as human food, with special reference to Kenya. *Water Sa*, 33(3).
- Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.
- Datona, M., 2014. 15. Socio-economic impacts of *Prosopis juliflora*-related charcoal trade in Gewane Woreda, Afar Region. *Managing Prosopis Juliflora for better (agro-) pastoral Livelihoods in the Horn of Africa*, pp.129.
- de Brito Damasceno, G. A., Ferrari, M., & Giordani, R. B. (2017). *Prosopis juliflora* (SW) DC, an invasive specie at the Brazilian Caatinga: phytochemical, pharmacological, toxicological and technological overview. *Phytochemistry reviews*, 16(2), 309-331.
- De Carvalho Nogueira, F., Pagotto, M. A., Aragão, J. R. V., Roig, F. A., de Souza Ribeiro, A., & Lisi, C. S. (2019). The hydrological performance of *Prosopis juliflora* (Sw.) growth as an invasive alien tree species in the semiarid tropics of northeastern Brazil. *Biological Invasions*, 21(8), 2561-2575.
- De Souza Nascimento, C. E., Tabarelli, M., da Silva, C. A. D., Leal, I. R., de Souza Tavares, W., Serrão, J. E., & Zanuncio, J. C. (2014). The introduced tree *Prosopis juliflora* is a serious threat to native species of the Brazilian Caatinga vegetation. *Science of the Total Environment*, 481, 108-113.
- Ekens, P., Simon, S., Deutsch, L., Folke, C., & De Groot, R. (2003). A framework for the practical application of the concepts of critical natural capital and strong sustainability. *Ecological economics*, 44(2), 165-185.
- El-Keblawy, A., & Al-Rawai, A. (2005). Effects of salinity, temperature and light on germination of invasive *Prosopis juliflora* (Sw.) DC. *Journal of Arid Environments*, 61(4), 555-565.
- Girma, M., Urge, M., & Animut, G. (2011). Ground *Prosopis juliflora* pods as feed ingredient in poultry diet: effects on growth and carcass characteristics of broilers. *Int. J. Poult. Sci*, 10, 970-976.
- Goodwin, C. J., & Goodwin, K. A. (2016). *Research in psychology methods and design*. John Wiley & Sons.
- Haji, J., Schaffner, U., Legesse, B., & Dadie, K. B. (2018). *Impacts of Prosopis spp. on Environment and Livelihoods in East Africa: Evidence from Ethiopia and Kenya* (Doctoral dissertation, Haramaya University).
- Haregeweyn, N., A. Tsunekawa, M. Tsubo, D. Meshesha, and A. Melkie. (2013). Analysis of the invasion rate, impacts and control measures of *Prosopis juliflora*: A case study of Amibara District, Eastern Ethiopia. *Environmental*



- Hassen, A. (2008). *Vulnerability to drought risk and famine: Local responses and external interventions among the Afar of Ethiopia, a study on the Aghini Pastoral Community* (Doctoral dissertation).
- Ilukor, J., Rettberg, S., Treydte, A., & Birner, R. (2016). To eradicate or not to eradicate? Recommendations on *Prosopis juliflora* management in Afar, Ethiopia, from an interdisciplinary perspective. *Pastoralism*, 6(1), 1-8.
- Kueppers, L. M., Snyder, M. A., Sloan, L. C., Cayan, D., Jin, J., Kanamaru, H., ...& Weare, B. (2008). Seasonal temperature responses to land-use change in the western United States. *Global and Planetary Change*, 60(3), 250-264.
- Kumar, S. S., Selvakumar, P., & Sreeja, P. (2015). A Study on *Prosopis juliflora*: Still a Valuable Species in Arid and Coastal Areas of Tamilnadu. *Journal of Advanced Research in Geo Sciences & Remote Sensing*, 2(3).
- Lenachuru, C. (2003). Impacts of *Prosopis* species in Baringo District. In *Proceedings of workshop on integrated management of Prosopis species in Kenya, Workshop held at Soi Safari Club, Lake Baringo* (pp. 1-2).
- Longley, C., & Wekesa, M. (2008). Improving Drought Response in Pastoral Areas of Kenya; Lessons and recommendations. *London: ALNAP*.
- Martin, R., Linstädter, A., Frank, K., & Müller, B. (2016). Livelihood security in face of drought—assessing the vulnerability of pastoral households. *Environmental Modelling & Software*, 75, 414-423.
- Maundu, P., Kibet, S., Morimoto, Y., Imbumi, M., & Adeka, R. (2009). Impact of *Prosopis juliflora* on Kenya's semi-arid and arid ecosystems and local livelihoods. *Biodiversity*, 10(2-3), 33-50.
- Meyers, L. S., Gamst, G., & Guarino, A. J. (2016). *Applied multivariate research: Design and interpretation*. Sage publications.
- Mwangi, E., & Swallow, B. (2005). Invasion of *Prosopis juliflora* and local livelihoods: Case study from the lake Baringo area of Kenya. *Nairobi, Kenya: World Agroforestry Centre*.
- National Drought Management Authority (2014). Garissa County report
- Oduor, N. M., & Githiomi, J. K. (2013). Fuel-wood energy properties of *Prosopis juliflora* and *Prosopis pallida* grown in Baringo District, Kenya. *African Journal of Agricultural Research*, 8(21), 2476-2481.
- Oliveira, B. F., Costa, G. C., & Fonseca, C. R. (2018). Niche dynamics of two cryptic *Prosopis* invading South American drylands. *Biological Invasions*, 20(1), 181-194.
- Pasiecznik, N. M., Felker, P., Harris, P. J., Harsh, L., Cruz, G., Tewari, J. C., ...& Maldonado, L. J. (2001). *The 'Prosopis Juliflora'-'Prosopis Pallida' Complex: A Monograph* (Vol. 172). Coventry: HDRA.
- Sato, T. (2013). Beyond water-intensive agriculture: Expansion of *Prosopis juliflora* and its growing economic use in Tamil Nadu, India. *Land use policy*, 35, 283-292.
- Silvestri, S., Bryan, E., Ringler, C., Herrero, M., & Okoba, B. (2012). Climate change perception and adaptation of agro-pastoral communities in Kenya. *Regional Environmental Change*, 12(4), 791-802.
- Simiyu, L., Shitanda, D., Kagiri, M., Mukonyi, K., & Gichua, M. (2017). *Properties of prosopis juliflora and its potential uses in Asal Areas of Kenya*, Unpublished PhD, JKUAT
- Sirmah, P., Muisu, F., Mburu, F., Dumarçay, S., & Gérardin, P. (2008). Evaluation of *Prosopis juliflora* properties as an alternative to wood shortage in Kenya. *Bois et forêts des tropiques*, 298(4), 25-35.
- Tabbush, P. (2010). Cultural values of trees, woods and forests. *Farnham, Surrey*.
- Teller, C., & Hailemariam, A. (2011). The complex nexus between population dynamics and development in Sub-Saharan Africa: a new conceptual framework of demographic response and human adaptation to societal and environmental hazards. In *The Demographic Transition and Development in Africa* (pp. 3-16). Springer



- Tompkins, E., &Adger, W. N. (2004). Does adaptive management of natural resources enhance resilience to climate change? *Ecology and society*, 9(2),341-360.
- Zeila, A. A., Mwangi, E., &Swallew, B. (2004). Prosopisjuliflora: Boon or bane for dryland agroforestry. *The Prunus Tribune, Jan–March*.
- Zeray, N., Legesse, B., Mohamed, J. H., &Aredo, M. K. (2017). Impacts of Prosopis juliflora invasion on livelihoods of pastoral and agro-pastoral households of Dire Dawa Administration, Ethiopia. *Pastoralism*, 7(1), 7.
- Zhong, L., L. Liu and Y.Liu (2010). Natural Disaster Risk Assessment of Grain Production in
- Ziervogel G., Bharwani S., Downing T.E (2005). Adapting to climate variability: pumpkins, people and policy. *Natural Resources Forum*. 2006; 30:294–305

